Revegetation at Crater Lake National Park:
A Survey of Historic and Active "Orphaned" Sites.

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We too are the children
of the glacier…
And when we find the first
wild flower in spring,
we sense that primal knowing…
Somehow we too survived
the glacial snows.

Robert O. Petty

Cover photo: Phantom Ship with pollen swirls and snowbank as viewed from Sun Notch - a glacial valley truncated by the blast of Mt. Mazama.

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Introduction

Crater Lake National Park has a fascinating history of restoration projects conducted over the years. This report divides sites into 4 classifications to help prioritize revegetation/restoration needs:

Category R: Past Revegetation/Restoration Sites - these sites have a written history of revegetation which had various rates of success.

Category A: Active Sites – these sites are currently in use and impacted by visitors.

Category H: Historic Sites – historic sites with various revegetation needs. Most of these sites are naturally revegetating.

Category Q: Large Scale Quarry Sites – large areas such as rock quarries and dumpsites that would require heavy machinery and major earth moving to restore and revegetate.

About this Report

This report is the culmination of the many hours I spent researching restoration projects by digging through old files sequestered in the attic of the resources management building, searching park databases and conducting interviews with staff who were in involved in restoration projects over the years. It also required many interesting hours in the field evaluating sites, some delightfully pleasant, others with the unfortunate company of multitudes of mosquitoes. Each site was re-located and inventoried for plant species composition and abundance, current condition of the site and if applicable, for successes and failures past restoration. It was a summer spent investigating, most joyfully, the revegetation needs at Crater Lake National Park. My heartfelt gratitude goes out to my botany partner Kathryn Williams, Biological Technician, for her assistance and laughter in the field and to Chris Wayne, GIS Specialist, for his help with creating GIS maps

I conducted site surveys from June through September of 2008. I recorded site locations using hand held Garmin Global Positioning Systems (GPS) units. All Universal Trans-Mercator's (UTM's) are NAD 83, UTM Zone 10. I created all maps using ESRI's ArcView 9.2 GIS software. All photographs and maps are by the author unless otherwise noted.

Measures of Success

Each site was evaluated with the following questions:

1. What was the goal of the restoration?
2. What restoration techniques were used?
3. Which plant species were seeded or transplanted?
4. What percentage of species planted/transplanted survive today?
5. Are the damaged areas still visible?
6. Is degradation on-going?
7. What role did/do humans play in the restoration project?
8. Is another restoration project necessary?
9. How many years do managers wait to see if a project was successful?
10. Is natural revegetation (ie. allowing natural recruitment of plants to revegetate an area) considered a success?

The Restoration Environment at Crater Lake National Park

Biotic Factors Limiting Restoration Success

Many factors contribute to the success or failure of restoration projects at Crater Lake National Park. The high elevation, low-fertility soils, and long harsh winters coupled with the short but intense visitor season and limited staffing make restoration at Crater Lake a challenge.

Soil Types

The predominant soil type at Crater Lake is poorly developed pumice and ash with high silica content. This results in droughty, low-fertility soils, which are limited in organic matter and their water holding capacity. Soils in forested areas have higher fertility, however the largest impacts occur in developed areas. These areas are concentrated on pumice soils not coincidentally because of the views these areas impart. Construction activities, vehicle, and foot traffic impacts are heaviest in the very places unable to sustain them. Therefore improvements to the soil fertility and water holding capacity are critical to restoration success.

Short Growing Season

Snow often remains on the ground into July and can return again in late September, making for a very short growing season. This short window significantly affects the survivorship of transplants by limiting the time for root growth and establishment. It also limits the time frame for seed germination, growth, flowering and seed-set. This low rate of growth needs to be accounted for when planning, implementing and evaluating restoration projects.

Wind Scouring

Wind scouring is especially harsh along the caldera rim. After snow-melt, plants are exposed to extremely harsh conditions of intense sun and wind. Revegetation in these areas is difficult and has been largely unsuccessful because wind whips and desiccates plants. High winds also move soil away from plant roots thereby exposing them to desiccation.

Moisture availability after snow-melt

Precipitation during the summer months is low making irrigation necessary. Prior to 2004 watering was done primarily by hand using watering cans, fire bladder bags, or by an inefficient, gravity-fed hose and reservoir system set up in a truck bed (Coleman, 2005). In 2004 a gas-powered water pump was purchased, greatly improving watering capabilities. Watering at the Rim Village Cafeteria area currently involves using hoses to reach all areas of the revegetation, a time- consuming, labor-intensive strategy. This requires connecting a hose to the water valve across a busy lane of traffic, laying hose across the road and positioning sprinklers to reach the landscape islands without watering visitors on the sidewalks. Mulching has also been used to increase moisture around plants and to reduce desiccation. Several revegetation projects have used the chemical *Agrosoke*, a water-retaining polymer crystal.

Soil Compaction

Many sites are degraded from soil compaction from vehicles and/or foot traffic. This requires soil scarification and in some cases augmentation before planting.

Solutions to Factors Limiting Success

Improve water-holding capacity

Water holding capacity has been improved by amending soils with peat moss. This technique was used in the original Rim Village Promenade restoration in the 1930's. Study plots set up in the park by the Natural Resource Conservation Service (NRCS) showed that the combination of peat moss and slow release fertilizer produced the best results for seedling establishment (Coleman, 2005). The transport of soil amendments from one area of the park to another must be done cautiously to avoid the inadvertant spread of weeds. Shredded mulch is also effective at slowing water loss and protecting seedlings from the elements. The use of the chemical *Agrosoke* is not recommended because it can draw moisture away from neighboring vegetation.

Micro sheltering

Rocks, logs or other transplanted vegetation can be used to shelter seedlings from wind, sun, snow/ice and visitor trampling. Transplants have the added advantage of introducing native microbes and mychorrizae, which may benefit seedlings.

Frost cloth

Frost cloth has been applied in some revegetation projects, however it should be used cautiously because heavy snow loads may cause the cloth to become too heavy and damage seedlings.

Erosion control matting

Many sites have used erosion control matting made from coconut husk fiber. This has been effective in some areas to hold soil in place and allow seeds to germinate. At some sites the matting has been applied to thickly and has actually limited plant growth. Another "biodegradable" plastic matting has been used with limited success. This type of matting may degrade eventually but was in near perfect condition at Vidae Falls almost 10 years after application posing other resource questions (Fig. 6). For example, does the application of plastic matting pose a danger to wildlife if it becomes detached from the area? At Rim Village the use of erosion control matting mixed with shredded hay is so thick that it appears to be impeding the growth of seeds in some areas.

Site adapted seeds/transplants

Site-native seeds and transplants have shown the greatest success rate in revegetation projects. Seed collection and transplants should be chosen from surrounding vegetation to increase chances of success. This also preserves the genetic integrity of plant communities. Plant community composition should also be monitored to maintain proportions of species in the revegetated areas.

Human Factors Limiting Restoration Success

Limited staff and money

Restoration projects at Crater Lake follow a predictable pattern. Money and staff are allocated to develop and implement a project, however very little money is available for subsequent monitoring and upkeep of the landscape. If the original cause of degradation remains, the site becomes degraded once again. A Biological Technician is hired to evaluate the sites, resulting in another restoration plan or an actual restoration project 5-10 years later at greater cost than routine upkeep would have been. This pattern has been followed repeatedly over the past 25 years, perhaps longer.

Visitor Impacts

Because of the continued visitor impact at many sites, the pattern of restoration and re-degradation will continue unless a long-term approach is taken, or unless certain areas are deemed to be "sacrifice zones". For example, at Rim Village many restoration efforts have come and gone, however the visitors keep coming and continuing certain behaviors (short-cutting through landscapes, trampling vegetation, pulling out fragile fencing, etc.). Restoration at this site must include barriers and sinage to limit these activities, otherwise it should be considered an ongoing restoration project that will need to be revegetated year after year. High visitation areas should also be looked at differently than more natural sites. For example Rim Village is an altered landscape that should take into account human ecology and landscape psychology to strategically move people through the landscape. In other words, this area will continue to be impacted and should be planned accordingly and may have to look less "natural" (e.g. employ substantial fencing, rock wall barriers or other mechanisms to control flow) in order to protect fragile soils and plants.

The Sites

Category R: Former Revegetation/Restoration Sites

1. Vidae Falls Picnic Area

Location: Off East Rim Drive at end of road to Crater Peak Trailhead.

GPS: 4748157 N, 573721 E +/- 29', NAD 83

Date of Visit: July 13, 14, and August 14, 2008

Description: Vidae Falls Picnic area is located on a gently sloping bench between Sun Creek and Vidae Creek at 6650' elevation in a sub-alpine forest and meadow ecotone. The closed canopy is dominated by old growth *Tsuga mertensiana* (mountain hemlock) and *Abies sp.* (fir) with a species-poor understory composed primarily of *Luzula hichcockii* (woodrush) and *Carex sp.* (sedge sp.). The meadow community is a mosaic of low herbaceous vegetation dominated by *Lupinus andersonii, Aster ledophyllus, Aster modesta, Ericameria bloomeri,* and several grass and sedge species. The site also has dispersed clumps of colonizing *Tsuga mertensiana* and dense pockets of seral *Pinus contorta* (lodgepole pine) from former disturbance.

Revegetation History: Restoration of the site began in 1999 following road grading, paving and construction of new picnic sites. Construction activities along with use of a "social road" by park staff to access and survey Sun Creek which flows along the eastern side of the site, had degraded the site and decimated vegetation (Fig.2). Native seed was collected in the Park and propagated by the Natural Resource Conservation Services (NRCS) and Forest Farms Nursery. The soil was scarified in preparation for planting. Container-grown plants and seeds were returned to the Park in 2000 for out-planting. Park staff was assisted by the Youth Conservation Corps and Friends of Crater Lake to restore the impacted areas. The following species were propagated or transplanted:

Abies magnifica var. shastensis (Shasta red fir)
Abies lasiocarpa (subalpine fir)
Pinus contorta (lodgepole pine)
Tsuga mertensiana (mountain hemlock)
Ribies erythrocarpum (Crater Lake currant)
Aster ledophyllus (Cascade aster)
Ericameria bloomeri (rabbitbrush)
Erigonum mariflorum (mountain buckwheat)
Polygonum newberryii (Newberry's knotweed)
Spraguea umbellatum
Bromus carinatus (California brome)
Carex pachystachya (thick-headed sedge)
Carex spectablis (showy sedge)
Carex halliana (Hall's sedge)
Elymus glaucus (blue wild rye)
Luzula hitchcockii (smooth woodrush)
Stipa occidentalis (western needlegrass)

Restoration Success/Failure: This project had approximately 30% success. The Social Road (Fig.2) and revegetated picnic table area (Fig.3) are still clearly visible with mostly barren soil and sparse vegetation compared to the meadow it runs through. The jute erosion matting is wadded up on the sides caught by downed logs, and the green "photodegradeable" plastic matting is clearly visible and does not appear to be degrading after 10 years (Fig. 6). Only two of the transplanted *Tsuga mertensiana* seedlings survive along with sparse grasses, sedges and forbs (Fig. 4,5)

A survey of the Social Road and picnic table site found the following species remaining in the Social Road revegetation:

Tsuga mertensiana (mountain hemlock), two transplants and volunteers.
Pinus contorta (lodgepole pine)
Erigonum marifolium (mountain buckwheat)
Calyptridium ubellatum (pussypaws)
Elymus elymoides (squirreltail)
Bromus carinatus (California brome)
Carex sp.
Aster ledophyllus (Cascade aster)

The revegetation around the restrooms had approximately 20% success (Fig.7). This site also has clearly visible erosion matting wadded up in various places as well as the plastic "biodegradeable" matting. The area in front and behind the restrooms and along the culvert is especially barren. A survey of the restroom area found the following species:

Tsuga mertensiana (mountain hemlock) volunteers
Pinus contorta (lodgepole pine) volunteers
Calyptridium ubellatum (pussypaws)
Lupinus sp.
Carex sp.
Mimulus lewisii (Lewis' monkeyflower)

Recommendations:

The jute and plastic erosion matting should be removed from the Social Road, picnic table site and restroom area where possible (left intact if removal would jeopardize the plants). Since the sites were not maintained properly after the original restoration, most of the areas need a full restoration once again. This will include removing old matting, seeding, transplanting and placing new matting, and regular watering.

Fig. 2 – Vidae falls social road before restoration. Photo courtesy of Cheri Killam-Bomhard, Crater Lake NP.

Fig. 3 - Vidae falls picnic table area before restoration. Photo courtesy of Cheri Killam-Bomhard.

Fig. 4 - Vidae falls social road revegetated.

Fig. 5 – Vidae falls social road and picnic table area after restoration.

Fig. 6 – Vidae Falls "photodegradable" erosion matting used on social road and restroom area.

Fig. 7 – Vidae Falls restroom revegetation.

2. Lost Creek Campground

Location: Three miles south of East Rim Drive on Pinnacles Road.

GPS: 4747896 N, 578489 E, NAD 83.

Date of Visit: July 9, August 18, 2008

Description: Lost Creek Campground is located between Pinnacles Road and Lost Creek at an elevation of 5792 feet. The canopy is dominated by *Pinus contorta* (lodgepole pine) with a smaller amount of *Abies* x *shastensi*s (Shasta red fir). The dominant understory vegetation in restoration sites consists of *Carex sp.*, *Elymus elymoides* (squirreltail), *Achnatherum occidentale californicum* (western needle grass), *Bromus carinatus* (California brome), *Ericameria bloomeri* (rabbitbrush), and *Lupinus andersonii* (Anderson's lupine). Soils are poor in this area and consist primarily of pumice and ash deposits.

Restoration History:

1989-1990

Revegetation of this site began following a campground remodel to increase the number of campsites. In 1989, 24 test plots were established in site #1 (Fig. 8) with the following description of planted species: *Grass sp., "woody vegetation", 3 lodgepole pine seedlings per plot for a total of 46 individuals*. Seeds and transplants were collected from locations within a four mile radius of the campground, although there is no documentation of species collected. Observations in 1990 indicated that all 46 individuals had survived (Coleman, 2005).

In June of 1990, 184 *Pinus contorta* (lodgepole pine) saplings were removed from the sewage lagoons near Mazama campground and 100 were transplanted in revegetation sites 1, 2, and 3 (Fig. 8) the same day. The remaining trees remained in the nursery until July when they were planted. Observations in 1990 indicated that all 184 transplants had survived.

Watering of sites was consistent in 1989 and 1990 with the transplants being watered at initial planting and once a day for four weeks. Watering continued after the establishment period of four weeks but was decreased to every two to three days.

There is no information about erosion matting or other treatments for the plots.

Restoration Success/Failures: All of the restored sites have been successful and contain healthy saplings, grasses, wildlflowers and forbs. Since there was no information on exactly which species were seeded, it cannot be determined if the plants that exist today are from natural recruitment or from the restoration project. There is low mortality of transplanted *Pinus contorta* in all sites as well as healthy volunteers of *P. contorta*, *Tsuga Mertensiana* (mountain hemlock) and *Abies* x *shastensis* (Shasta red fir). The understory is a mix of grasses, sedges and forbs. Each of the sites were surveyed and the following species were found:

Site #1 (Fig. 9)
Pinus contorta (lodgepole pine)

Abies x *shastensis* (Shasta red fir)
Penstamon cinicola (ash penstamon)
Carex sp.
Lupinus sp.
Erigonum umbellatum (sulphur buckwheat)

Site #2 (Fig.10)
Pinus contorta
Calyptridium umbellatum (pussypaws)
Carex sp.
Erigeron perigrinus (subalpine daisy)
Solidago canadensis (Canada goldenrod)
Lupinus sp.

Site #3 (Fig.11)
Pinus contorta
Abies x *shastensis* (Shasta red fir)
Gayophytum diffusum (spreading groundsmoke)
Lupinus sp.
Caliptridium umbellatum
Elymus elymoides (squirreltail)
Arctostaphylos navadensis (pinemat manzanita)

Site #4 (Fig.12)
Pinus contorta
Carex sp.
Elymus elymoides
Bromus carinatus (California brome)
Epilobium angustifolium (fireweed)

Site #5 (Fig.13)
Pinus contorta
Sparse *Carex sp.*

The other sites that were in need of restoration in 1990 which include # 6 (fig. 14), #7 and #8 (Fig.15) remain mostly bare of vegetation. Run-off from Grayback road into site #6 is forming an erosional gully that flows into Lost Creek.

Recommendations:

Site #6 is in greatest need of restoration due to the erosional run off into Lost Creek and the lack of vegetation throughout the site. Sites #7 and 8 should also be restored.

Another high priority site is the leach field that was installed in July 2004 but was never restored (Fig. 16,17). This area is in plain view of visitors as they enter into the campground. The site is barren except for a few *Pinus contorta* and *Abies* x *shastensis* volunteers.

Fig. 9 – Lost Creek campground reveg site #1

Fig.10 – Lost Creek campground reveg site #2

Fig.11 – Lost Creek campground reveg site #3

Fig. 12 – Lost Creek campground reveg. site #4

Fig. 13 – Lost Creek campground reveg sites#5 and #6.

Fig. 14 – Lost Creek campground reveg site #6 with erosion gully draining into Lost Creek in foreground

Fig. 15 – Site #8 still in need of revegetation.

Fig. 16 – Lost Creek campground leach field. View toward restrooms.

Fig. 17 – Lost Creek campground leach field. View towards information kiosk.

3. Sun Notch Overlook

Location: Overlook off of East Rim Road.

GPS: 4750405 E, 573744 N, +/- 18’ NAD 83

Date of visits: July 11, August 14, 2008

Description: Sun Notch is a popular hike-in viewpoint/overlook of Crater Lake with excellent views of Phantom Ship (cover photo). The area consists of a south aspect, moderately sloping, sub-alpine meadow at 7,104 ft. elevation overlooking Crater Lake between Applegate Peak and Dutton Ridge. Before visitation increased in this area, it was considered to be a pristine sub-alpine meadow and seeds were collected here for restoration projects at Rim Village. The dominant coniferous vegetation at this site include *Abies* x *shastensis* (Shasta red fir), *Tsuga mertensiana* (mountain hemlock), and *Pinus albicaulis* (whitebark pine).

Current Conditions: The area has a network of social trails. The first social trail begins about 20 feet from the trailhead and goes to the left around a group of mountain hemlock (Fig. 25). The official trail is excessively wide in many places and has sections with significant erosion over exposed tree roots. The remains of small social trails go through the center of the meadow (Fig. 24). Another eroded social trail leads to the right off of the main trail and is so wide it looks like an official trail (Fig. 26). A network of social trails winds in and out of the forested rim area (Fig. 19), down into the caldera (Fig. 20), towards the west to Applegate Peak (Fig. 22) and the east to Dutton Ridge (Fig. 23). Wide areas of trampling have denuded the vegetation to bare soil (Fig.21).

Revegetation History: From August-October of 1993 a restoration project was conducted by Park Service Biological Science Technicians with the help of Sierra Club volunteers. No further re-vegetation has been attempted. This project had moderate success, especially in restoring the meadow social trail, however, years of neglect have returned the site to pre-restoration status.

Site Preparation:
White fir logs were salvaged from a fuel reduction project in the Panhandle (southern part of the park) and were placed in strategic “view site” locations to stop foot traffic from continuing down into the caldera and to indicate the end of the main trail. Barriers were built from eight-inch diameter logs in a “hitching post” style with upright posts sunk 2-3 feet into the ground. Logs were also scattered along social trails in the meadow and rim area. Social trails were scarified, re-graded to natural grade and covered with erosion-control matting. Matting was secured with metal stakes to prevent movement by wind. Stakes were to be removed 2 years after the project.

Seeding:
Native seeds were collected during summer 1993 in forest and meadow communities of the National Park including Sun Notch, Sun Creek, Dutton Ridge and Greyback Ridge. Revegetation sites were seeded in October of 1993. The site was not evaluated for seedling emergence or revegetation success. Subsequent monitoring information is lacking.

Upper meadow sites were seeded with the following:
Elymus elymoides (squirreltail)
Stipa occidentalis (western needlegrass)
Polygonum newberryi (Klamath knotweed)

Lupinus latifolius (broad-leaved lupine)
Carex spp. (sedge sp.)
Eriogonum marifolium – (mountain buckwheat)

Lower wooded sites were reseeded with:
Luzula sp. (woodrush)
Lupinus latifolius

Restoration Successes/Failures: The lower wooded site has 100% success. There is no evidence of this social trail. The upper meadow site with the small social trail was 70% successful. The small social trail is still evident from the lower meadow where vegetation on the trail is sparse (Fig. 24). About 1/3 of the way up the social trail disappears and is obscured by the following species:

Elymus elymoides
Stipa occidentalis
Polygonum newberryi
Lupinus latifolius
Carex sp.
Eriogonum marifolium
Castelleja arachnoidea (cobwebby paintbrush)
Calyptridium umbellatum (pussypaws)

The success rate is 10% along the rim. Some of the social trails are no longer used because of blockage by downed logs, however numerous new and existing trails wind in and out of the area (Fig. 19). There is no evidence of the "hitching post" style barriers. The vegetation is denuded and social trails continue to the west toward Applegate peak (Fig. 22) and east toward Dutton peak (Fig. 23). A significant social trail goes down 20 feet into the caldera to a precipitous viewpoint of Phantom Ship (Fig. 20).

Recommendations: A new plan for flow of foot traffic at Sun Notch is vital because visitors will continue to look for the shortest distance to the rim as possible. Social trails through the meadow and at the rim should be revegetated with on-site native seeds, with the exception of Crater Lake current *Ribies erythrocarpum* which is a host for the whitebark pine blister rust fungus (see Rim Village cafeteria/whitebark pine restoration). Log barriers should also be placed to direct traffic flow. Interpretive sineage should be placed to educate visitors about the delicate sub-alpine meadow ecosystem and encourage responsible hiking. During spring melt-out the trail should be marked so that social trails don't develop when visitors cannot locate the main trail. Species recommended for seeding are as follows:

Lupinus andersonii (Anderson's lupine)
Aster ledophyllus (Cascade aster)
Ericameria bloomeri (rabbitbrush)
Hackelia micrantha (blue stickseed)
Agoseris aurantiaca (orange agoseris)
Aquilegia formosa var. *Formosa* (red columbine)
Ebilobium angustifolium (fireweed)
Bromus carinatus (California brome)
Elymus elymoides (squirreltail)
Elymus glaucus (wild blue rye)

Fig. 19 – Sun Notch social trail network at caldera rim.

Fig. 20 – Sun Notch social trail heads down into caldera to view Phantom Ship.

Fig. 21 – Sun Notch vegetation trampling as social trails widen.

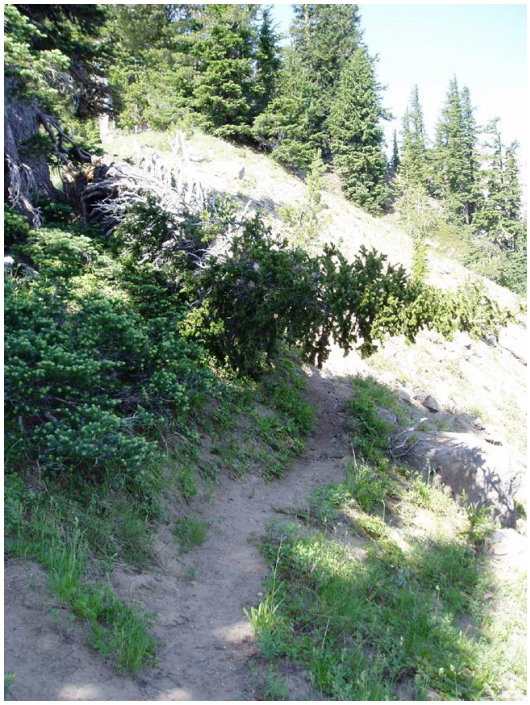

Fig. 22 – Sun Notch social trail continues toward Applegate Peak.

Fig. 23 – Sun Notch social trail continues toward Dutton Peak.

Fig. 24 – Sun Notch small social trail through meadow 25 years after revegetation.

Fig. 25 – Sun Notch first social trail begins near trail head.

Fig. 26 – Sun Notch wide social trail looks official.

4. Rim Village – Cafeteria Landscape and Whitebark Pine Restoration

Location: This site is at the end of Munson Valley Road and receives the bulk of visitor traffic.

GPS: 44751330 N, 569740 E +/- 20 ft. NAD 83.

Dates of visits: June 30, July7, 8, 16, August 4, 14, 15, 2008.

Description: This site is the first viewpoint of Crater Lake for visitors entering the park from the south. It consists of a variety of paved paths and viewpoints, which extend along the promenade at the edge of the caldera. It also serves as the hub of visitor services which includes a visitor center, cafeteria, gift shop and the Crater Lake Lodge. The site receives heavy vehicle and foot traffic and the landscape suffers from visitor trampling and short cutting through vegetation islands that separate the paved pathways. After decades of revegetation projects this site remains the "achilles heel" of restoration at Crater Lake National Park.

Restoration History:

Restoration efforts began here in the 1930's when the need to control visitation became clear. Prior to this time, visitors indiscriminately parked vehicles, hiked and camped along the caldera rim. The landscape suffered from these activities and exposed soils created dusty conditions along the rim. An early restoration project included creation of designated parking areas, pathways and a landscape plan with revegetation of denuded areas to mimic the pristine conditions found at that time at Sun Notch. Native grasses (with the exception of Kentucky bluegrass), forbs, shrubs (including *Spirea* and *Sorbus sp.*) and Mt. Hemlock were planted. Soil amendments were added to increase fertility of the pumice soils. This included hand removal of 8-12 inches of pumice soil, addition of manure and a covering of "peat moss" from a bog in Munson Valley. Top soil collected from Rim Road was then added to the site. Subsequently, sod was used for restoration. In 1934 three Civilian Conservation Corps men were stationed full time at Rim Village to care for the plantings, an interesting contrast to today's park budget and/or priorities which cannot fund the necessary labor for post-revegetation maintenance.

Another ambitious restoration project began in 2003 following the construction of a new cafeteria and gift shop. Traffic patterns were changed and parking was re-routed so the parking lot between the cafeteria and the rim could be removed (fig. 39a). In its place a new landscape was created and an ambitious revegetation project began (fig. 39b).

Whitebark Pine Restoration and Blister Rust Resistance Experiment

In summer of 2008 the final phase of the Rim Village cafeteria restoration began. The purpose of this project was to restore *Pinus albicaulis* (whitebark pine) to the landscape and simultaneously conduct a white pine blister rust resistance experiment. Blister rust is a fatal disease caused by the fungus *Cronartium ribicola*, which has infected most of the trees in the Rim Village promenade landscape and many others throughout the park. This pathogen, along with western bark beetle, are causing a precipitous decline in whitebark pine throughout the western states. There is evidence that fungal endophytes, naturally occurring in old growth whitebark pines, may be effective at increasing resistance to *C. ribicola* (Ganley, Sniezko and Newcombe, 2008).

This project consists of the planting of 250 *Pinus albicaulis* (whitebark pine) seedlings into the Rim Village cafeteria landscape and the planting of 200 additional seedlings as part of the blister rust resistance experiment. Seedlings from parent trees on the Rim Village Promenade had been grown at the U.S. Forest Service Dorena Genetic Research Laboratory in Cottage Grove, OR. These seedlings are 3-6" tall with a cone-tainer of 10 inches and are ready for out-planting.

On June 30, 2008, myself and Kathryn Williams (also a Bological Technician) harvested 10 needles each from 10 healthy looking Rim Village Promenade *P. albicaulis* trees with no visual signs of blister rust infection for a total of 100 needles. These needles were then shipped to the University of Idaho for endophyte extraction and culturing. There is evidence that needles containing the endophyte fungus have some resistance to the blister rust spores which enter into the plant via the stomata. One hundred seedlings were then innoculated with the endophyte fungus (another 100 are the control group). To protect the seedlings in the landscape, I coordinated with the Crater Lake National Park Roads Crew to place boulders (3' to 5' in size) on the landscape to shield the seedlings from intense sun and wind, and to keep them from being trampled by visitors. The area is fenced with the same plastic pole and rope fencing that has had mixed success protecting the new landscape from foot traffic.

Since the seedlings have not been hardened to endure the harsh environment and poor soils at Rim Village, the mortality rate for the seedlings could be very high if they are planted in the new landscape. It is my recommendation that the experimental group of seedlings be moved to a more suitable location with higher chance of success. The other 250 seedlings can be used for the final phase of restoration in the cafeteria landscape.

Restoration Successes/Failures: The original design of the landscaping at this site included topography, an in-ground watering system, and fencing/physical barriers to match the National Park Service rustic architecture at the site. These three items were subsequently cut from the final landscape design leaving the plantings subject to heavy foot traffic and short-cutting by visitors. To alleviate the trampling, a temporary plastic fence with roping was approved and installed (Fig. 33, 39), however the soils are so hard it is very difficult to keep the poles upright (Fig. 36) and many hours of staff time are involved in maintaining the fencing. Various techniques have been employed to strengthen the poles such as wood shims and pole sockets with little success (Fig. 33,36,38,39). During snowmelt it is especially challenging to install the poles adequately to protect the landscape because visitors do not want to walk over snow and because the poles fall quickly as snow recedes (Fig. 27, 28). On August 15, 2008 rebar was installed and the plastic poles were slid over the top. This gave more strength and stability to the poles and improved the fence barrier.

To water the landscape a hose must be connected to the restrooms across a busy lane of traffic and laid across the roadway (Fig. 37). Again, many hours of staff time are required to move hoses and sprinklers across the landscape. Some areas had 100% mortality and are barren of any vegetation (Fig. 32, 35). All that remains in these areas are pieces of torn erosion matting (Fig. 35). Some areas have had moderate success, especially the plantings closer to rim and behind the cafeteria (Fig 31, 34). This success is due in part to more fertile soils in the original landscape islands closer to the rim and less foot traffic behind the cafeteria. The upland islands are over the former parking lot where the soils are shallow and infertile, making growth very difficult (Fig. 29, 30).

The original seeding of the new cafeteria landscape islands consisted of:

Shrub species

Lonicera involucrata (twinberry honeysuckle)
Salix sp. (willow - wetland sp.unless it was *S. scoulariana*)
Sambucus racemosa (red elderberry)
Sorbus scopulina (western mountain ash)
Spiraea splendens (subalpine spiraea)

Forb species

Achnatherum coccidnetale ssp. Californicum (western needlegrass)
Agoseris aurantiaca (orange agoseris)
Arabis platysperma (flatseed rockcress)
Aster ledophyllus (Cascade aster)
Aster modestus (few-flowered aster)
Broumus carinatus (California brome)
Carex halliana (Oregon sedge)
Carex pachystachya (thick-headed sedge)
Castelleja applegatei (Applegate's paintbrush)
Clatonia sp. (likely to be western spring beauty *C. lanceolata*)
Elymus elymoides (squirreltail)
Elymus glaucus (western ryegrass)
Ericameria bloomeria (rabbitbrush)
Eriogonum umbellatum (sulphur buckwheat)
Juncus parryi (Parry's rush)
Juncus sp.
Lupinus andersonii (Anderson's lupine)
Lupinus lepidus (dwarf lupine)
Penstamon sp.
Senecio triangularis (arrowleaf groundsel)
Veratrum viride (green false hellebore)

This species list is rather puzzling because seven of them are wetland species (*Sambucus racemosa, Spiraea splendens, Aster modestus, Carex pachystachya, Elymus glaucus, Senecio triangularis, Veratrum viride*) and would not be expected to thrive in the arid, pumice soils of rim village. So it is not surprising that these species are absent from the landscape. Browsing by deer has taken its toll on the shrub species especially *Lonicera involucrata,* so that most shrubs are eaten down to bare branches. During spring snow-melt the landscape becomes exposed and very soggy so that foot traffic coming off of the snow onto the landscape produces significant visitor impact (Fig. 27).

A survey of the landscape islands found 6 of the 24 species remaining plus an additional two species (*Calyptridium umbellatum* and *Phacelia hastata*) that naturally colonized. None of the wetland species survive in the landscape. The following species occur in the islands with varying degrees of abundance:

Bromus carinatus – the most abundant in all landscape islands
Sorbus scopulina (mountain ash) – browsed by deer
Lonicera involucrata (twinberry honeysuckle) – browsed by deer
Lupinus sp. – sparse but doing better than other herbs.

Carex sp. – sparse to moderately distributed, doing best after lupine.
Calyptridium umbellatum (pussypaws) – sparsely found in one island.
Agoseris aurantiaca (orange agoseris) – sparsely found in three islands.
Phacelia hastata (silverleaf phacelia) – sparsely found in one island.

The landscape islands closer to the rim are revegetating faster than those closer to the buildings with the exception of the back area of the cafeteria which is doing quite well. The soils closer to the rim are more fertile and have received less snow-melt trampling, however the *Tsuga mertensiana* (mountain hemlock) that were transplanted in these islands have a mortality rate of 50%.

Recommendations:

1. A permanent fencing/barrier system must be installed in this landscape. The foot-traffic patterns were not designed with human ecology in mind, so visitors who want the most direct route to the rim to view the lake cut directly through the new landscape. Without a physical barrier, visitors will continue to take shortcuts and damage the plantings. Even with the rebar installed to strengthen the plastic poles, they are subject to pulling out by visitors.

2. A fencing system must also be installed around the all the planted shrubs to deter deer browsing.

3. A watering system must be installed in the landscape. This is a harsh, arid landscape and without regular irrigation the plantings will not survive.

4. Soils need augmentation to increase fertility in some areas, especially around the entrance to the cafeteria building.

5. The area near the cafeteria entrance had near 100% mortality and needs to be revegetated again after soil augmentation.

6. The 200 whitebark pine seedlings that are part of the blister rust resistance experiment should be planted in a more suitable location. The remaining 250 seedlings should be planted in the most fertile soils in the cafeteria landscape. If this is not possible, then micro-sites should be created using soils and boulders to increase chances of survival.

Fig. 27 – Rim Village revegetation trampling during snowmelt.

Fig. 28 – Rim Village reveg attempt to protect landscape during snowmelt.

Fig. 29 – Rim Village reveg in front of 1928 Building looking toward Crater Lake.

Fig. 30 – Rim Village reveg in front of Cafeteria.

Fig. 31 – Rim Village revegetation greater success of grasses and forbs closer to lake and higher fertility soils. High mortality of transplanted Mt. Hemlock.

Fig. 32 – Rim Village reveg near 100% mortality in high traffic area outside cafeteria.

Fig. 33 – Rim Village reveg installing pole sockets to hold poles.

Fig. 34 – Rim Village revegetation behind cafeteria is doing better.

Fig.35 – Rim Village reveg near 100% mortality on west side of cafeteria.

Fig. 36 – Rim Village reveg pole sockets unsuccessful in hard packed soil.

Fig. 37 - Rim Village reveg access to water across the street from landscape islands.

Fig. 38 – Rim Village reveg wood shims used to prop up poles.

Fig. 39 – Rim Village reveg pole sockets successful in better soils.

5. Mt. Mazama Collomia (*Collomia mazama*) Restoration

Location: Far west side of the park. From Forest Service Road 660 hike the Bald Crater Loop trail east toward Sphagnum Bog. Plots and original population are located about 10 feet north of junction with trail that goes south into Sphagnum Bog. Site is located along the historic road, north of the road and just south of the road (between the road and new trail) that was used as the hiking trail until 1997 when it was rerouted (fig. 40,43,45).

GPS: 4761174 N, 561020 E, NAD 83.

Date of site visit: August 12, 2008.

Site Description: The *Collomia mazama* (Fig. 42) population at Sphagnum Bog was severely impacted by historic road construction and by trampling from pack animals tied to a hitching rail located adjacent to the site. (Baldwin and Brunsfeld, 2001). The site is a located at an elevation of 5200' with a moderate slope dominated by a dense overstory of *Abies x shastensis* (Shasta red fir) and a sparse understory of scattered *Carex sp., Chimaphila umbellata* (Prince's pine) and *Aster foliaceus* var *parryi* (Leafy aster). There has been significant blowdown of trees, branches and bark which now covers half of the site obscuring many of the restoration plots (Fig.44).

Revegetation History:
In 1997 the hiking trail was re-routed off of the historic road and the hitching rail was a relocated. A restoration project was initiated in the fall of 1998 and spring of 1999 to restore the population of *C. mazama* that had been damaged by hiker and pack animal trampling (Fig. 41). Seeds were collected from Sphagnum Bog and Copeland Creek populations and propagated at the University of Idaho Forest Nursery Greenhouse. 500 seeds were stratified and divided into equal groups. Half were scarified with sandpaper while half were not scarified. Seeds were then germinated and grown in the nursery. Genetic studies were conducted and four parent plants were selected with the highest heterozygosity for vegetative cloning. In fall of 1998, 166 seedlings and 400 vegetative clones were planted. In spring of 1999, 442 seedlings and 200 vegetative clones were planted. Seedlings were backpacked into the site by a graduate researcher, park staff, and volunteers from the Friends of Crater Lake National Park. A total of 14 randomly selected plots were planted (Fig. 47). Holes were dug to a depth of approximately 15 cm using bulb planters, the plant roots were then loosened and the plants were placed into holes and the roots were covered with soil (Baldwin and Brunsfeld, 2001). The plants were then watered with a hand pump. In spring of 2000 a survivorship survey was conducted and found 65% of seedlings and 58% of vegetative clones surviving.

Restoration Successes/Failures:
This site had not been re-visited in eight years. Information is lacking as to the exact locations of plots and no permanent markers were placed during the restoration project. There is only a generalized line drawing of the planting locations with no geographic or natural features indicated on the map (fig. 47). The map has no plot sizes, number of seedlings planted per plot or genetic identity of seedlings (e.g. if they came from the Copeland creek or Sphagnum Bog populations). Lack of specifics made relocating plots difficult, so the general location of each plot was determined. Four of the southernmost plots (# 12,13,14 and 15) were completely covered in blowdown of trees, branches and bark so no *C. mazama* survived in those areas. Three other plots (# 5, 10, and 11) contained no individuals. The other plots ranged from 1-45 individuals (see plot map, fig.47). The largest number of individuals (265 plants) were found on the old roadbed. The original population area (#9) has 260 individuals.

The success of the restoration lies in the increase in population on the road, which was closed off to hiking during the trail re-route in 1997. This presumably allowed the original population (#9) to spread north into open habitat on the road. Continued tree fall on the road, as well as mis-directed hikers, now threatens this population. The other plots that are doing well are either adjacent to the original population and/or in more open areas free from downed limbs and trees.

This restoration project was a good learning experience on how *not* to set up a project. Without good maps and specific information on numbers of individuals before and after planting, plot sizes and locations, it is very difficult to assess the success or failure of the project. The original population (fig. 41) appears healthy and is presumably expanding, however since there is no data on how many individuals were in the original population or on the road it cannot be determined if this is really true. The re-route of the hiking trail appears to have been the best strategy for restoring the *C. mazama* population in this area. Since no *C. mazama* were planted in the original population area (#9) or on the road/trail, it appears that natural colonization and restoration occurred either from the original population source or from one of the adjacent restoration plots.

The mixing of populations from Copeland Creek and Sphagnum Bog for cloning and for outplanted seedlings is a bit troubling. This artificial movement of genes allowed the blending of alleles of this distinct population segment. The cloning also added 1208 plants (600 cloned, 608 seed grown) to the population from just 4 parent plants. This does not seem like a valid way of increasing the genetic diversity of the population. There is no discussion regarding the rationale behind this decision or the benefits/risks of the endeavor.

Recommendations: Much of the habitat in this area is unsuitable for *C. mazama*. Concentrating efforts to protect habitat at other locations makes better sense. If continued restoration is desired in this area it must be cleared of the downed logs, branches and other debris that is now covering *C. mazama* habitat. Since this closed canopy area is not ideal habitat, the highest priority for this site is to make sure that hikers take the trail re-route that leads them south of the *C. mazama* population on the old road/trail. Trail signage and trail work to make the diversion clear is vital.

Fig. 40 – Bert Springs trail diversion from old road bed is difficult to see.

Fig. 41 – Main *C. mazama* population south of old road bed.

Fig. 42 – *Collomia mazama* with *Chimapila* in original population area.

Fig. 43 – Bert Springs trail re-route south of restoration plots.

Fig. 44 – Restoration plots with tree fall.

Fig. 45 – Bert Springs trail re-route off of old road bed looking west toward *C. mazama* population.

Fig. 46 – *C. mazama* restoration plots upslope from old road bed.

Category A: Active Sites

6. Ballfield

Location: Off Munson Valley Road just south of Sleepy Hollow.
GPS: 4749374 N, 570199 E, +/- 29'
Date of visit: August 5, 2008

Description: Old ballfield converted into a storage area for roads and maintenance. This is also the location of an old shadehouse for plant propagation.

Current Conditions: This is a boneyard for large logs, boulders, gravel, asphalt, cement barriers, winter shelters, plows, flatbed truck, picnic tables, garbage/recycle bins, etc. The remains of an old shadehouse can be found in the northwest corner of the site near a water supply. Dead trees with metal tags and broken plastic pots are visible within the footprint of the former shade house. This was used for revegetation projects however nothing remains of the original metal framed shade house. No weeds were found.

Recommendations: This would be a great location to resurrect a shade house since it's so close to a water source and to headquarters. Since the area is still used by maintenance it does not make sense to do any revegetation at the site.

Fig. 48 – Remains of old shade house.

Fig. 49 – Boneyard for roads crew.

Fig. 50 – Storage for winter shelters, etc.

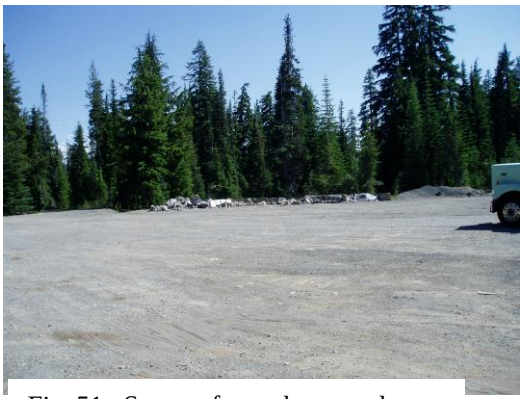

Fig. 51– Storage for rocks, gravel, etc.

7. Dutton Backcountry Camp

Location: Backcountry camp across from the Dutton Creek trail and Pacific Crest Trail junction.
GPS: 4749052 N, 567822 E, +/- 64', NAD 83
Date of visit: August 6, 2008.

Description: Backcountry camp with two camps located about 25 feet from Dutton Creek.

Current Conditions: The two camps did not have any major impacts. No weeds were seen. Mt. Mazama Collomia (*Collomia mazama*) is found in this area, especially south of the camp.

Recommendation: No revegetation needed.

Fig. 52 – Trail backcountry camp #1.

Fig. 52 – Backcountry camp #1.

Fig. 53 – Trail to backcountry camp #2.

Fig. 54 – Backcountry camp #2.

8. Garfield Water Tank

Location: Approximately one mile up Garfield Peak Trail.
GPS: 475111 N, 570896 E, +/- 8 ft. NAD 83
Date of visit: August 5, 2008

Description: Rock walls were built around water tank that services Crater Lake Lodge.

Current Conditions: Top of tank is barren pumice soil with little vegetation. Foot traffic is heavy and continues past the "Do not enter" barricade. Hikers detour off the Garfield Peak Trail switchback to the top of tank to view the Lodge to the south.

Recommendations: Top of tank should be revegetated and a barrier to foot traffic installed to keep hikers off the tank.

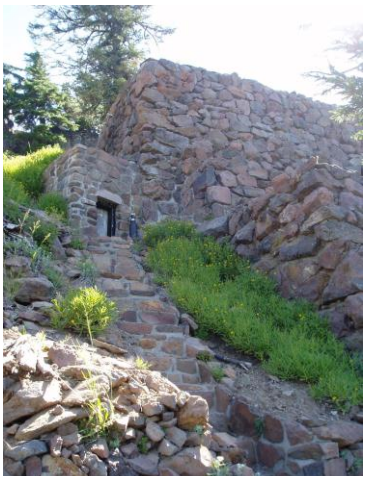

Fig. 55 – Water tank with rock work as viewed from Garfield Peak Trail

Fig. 56 – Garfield Peak trail leads hikers to top of water tank.

Fig. 57 – Top of water tank with very sparse vegetation.

Fig. 58 – Top of water tank looking back toward do not enter sign.

9. Mason Meeting Area

Location: First spur road to the north off of Grayback Road near Lost Creek Campground.
GPS: 4748187 N, 577884 E, +/- 13', NAD 83.
Date of visit: July 15, 2008.

Description: Meeting area has been used since the late 1940's and is an exclusive special use area for a private group. is in a Mt. Hemlock (*Tsuga* mertensiana) and Shasta red fir (*Abies x* shastensis) clearing at the end of the spur road off of Grayback road.

Current Conditions: Downed logs form a square area of about ¼ acre which contains a rock "shrine" with the Mason symbol carved on the top. Stacked rock seats and a stump "pedestal" have been placed within the area. A fire pit is about 20 feet from the main shrine area with partially burned logs. Nearby trees have been cut and burned. No trash or weeds were found at the site.

Recommendations: The site could be restored by scattering the logs and rocks. Some revegetation could be done in the central meeting area which has been trampled over the years, however natural revegetation will probably suffice.

Fig. 60 – Mason shrine and pedestal in meeting area.

Fig. 61 – Mason shrine.

Fig. 62 – Mason symbol carved on rock shrine.

Fig. 63 – Firepit with shrine area in background.

10. North Junction Overlook

Location: At the junction of North Entrance Road and West Rim Drive.
GPS: 4757256 N, 569261 E, +/- 10', NAD 83
Date of visit: July 10, 2008

Description: Heavily visited overlook into Crater Lake.

Current Conditions: Heavily impacted area with many wide social trails. A wide path (10-15' wide) leads from the parking area to a broken fence at the rim. Several social trails and trampled areas to the right and left of the main path lead into the forested rim area. A central "planter" area is also trampled and has sparse vegetation. The area beyond the fence is trampled indicating the fence does not stop foot traffic. Social trails also lead visitors to the area behind the fence to a precipitous slope. A wide social trail leads from the overlook up to another flat bench that is also trampled and devoid of vegetation. From this area another social trail continues up Llao Rock and leads visitors into a large Crater Lake Moonwort (*Botrychium pumicola*) population.

Recommendations: This is one of the most critical revegetation sites in the park. It is the first overlook of Crater Lake that visitors encounter when entering the park from the north. It is also the conduit for foot traffic up Llao rock, potentially trampling the Crater Lake Moonwort (*B. pumicola*), a rare plant that is a Federally listed Species of Concern and State of Oregon listed as Threatened.

Fig. 64 – Wide central trail, social trails and trampled vegetation with old rock work

Fig 65 – Central "planter" area trampling and sparse vegetation.

Fig. 66 – Inadequate fencing at rim overlook.

Fig. 67 – Social trails weave in and out of forested areas from central "trail".

Fig. 68 – Inadequate interpretive sinage looks as sad as the denuded site.

Fig. 69 – Wide social trail to view of Llao Rock.

Fig. 70 – Social trail continues up Llao Rock.

Fig. 71 – Social trail damage to vegetation.

Fig. 72 – Visitors walk indiscriminately from parking area to rim.

11. Raven Trail - Lodge Trailhead Area

Location: Trail begins at the southeast corner of the lodge across from paved walkway and heads south through pumice meadow following water line.
GPS: 4750872 N, 570193 E, +/-15 ft. NAD 83
Date of visit: August 5, 2008.

Description: Wide trail appears to be a social trail descends to the south from the SE corner of the lodge. Trail heads toward Munson Valley Rd.

Current Conditions: Wide trail which crosses several deep erosional gullies. Some rusted metal debris and water line stakes with flagging.

Recommendations: If this is an official trail it should be marked as the Raven Trail. It is unclear from the Lodge if this is really a trail or a social trail to a hang-out spot above Munson Valley Rd. Widening erosional gullies and trampled vegetation are the most pressing issues of this site.

Fig. 73 – Trail heading south from Crater Lake Lodge through pumice meadow.

Fig. 74 – Looking back up trail to Lodge.

Fig. 75 – Erosional gullies forming parallel to and across the trail.

Fig. 76 – Deep erosional gullies forming.

12. Whitebark Pine Picnic Area

Location: Along East Rim Drive near the turnoff to Cloudcap Overlook.
GPS: 4753593 N, 579308 E, +/- 15', NAD 83
Date of visit: July 10, September 10, 2008.

Description: Picnic area has 3 sites set in between small groups of whitebark pine (*Pinus albicaulis*).

Current Conditions: Parking, traffic flow and a small number of picnic tables (three) is a problem at this site. Unclear parking causes visitors to park chaotically, denuding vegetation and damaging trees and shrubs. As visitors park along the side they block traffic going around the loop road through the area. Vegetation is trampled in between picnic sites and broken pavement and gravel makes the site look neglected.

Recommendations: This site needs a complete overhaul to improve aesthetics, parking and traffic congestion. More picnic tables are needed to serve the number of visitors wanting to use the site. New paving and designated paved parking spaces for each site would eliminate the chaotic parking and trampling of vegetation (as was done at Vidae Falls Picnic Area). Revegetation of areas where cars currently park, and in between and around picnic sites is needed. This area could also use revegetation of whitebark pine since seedlings have been trampled or driven over.

Fig. 77 – Entrance to Whitebark Pine Picnic Area with broken pavement and off road impacts.

Fig. 78 – Traffic congestion and off road parking.

Fig. 79 – Traffic impacts on vegetation.

Fig. 80 – Denuded site needs revegetation.

Category H: Historic Sites

13. Fisch Construction Site

Location: Road cut begins about 20 feet down road from second pullout heading downhill from Rim Village. The Dutton Creek trail is adjacent to the site and can be seen from the lower part of the site.
GPS: 4751016 E, 569417 N. +/- 18 ft. NAD 83.
Date of visit: August 5, 2008.

Description: Road cut into forest leads downslope to old leach field. Many rock and tree push piles line the area around the road cut. Large boulders have been placed into drainage. Small rocks and gravel are also piled up in various locations around the site. A large area of pumice with no vegetation and several areas of trees laid over the road cut. Much of the area is devoid of vegetation although there is some natural recruitment of Mt. Hemlock (*Tsuga mertensiana*), Pussy paws (*Calyptridium umbellatum*), *Lupinus sp.* and grass sp.

Recommendation: This site is visible from both Munson Valley road and from Dutton Creek Trail. The road cut was put in without permission to remove an old leach field. This damaged a historic road (Steve Mark, personal communication) so there is a historic component that may be in need of restoration. The erosional gully filled in with boulders is continuing to erode and is the most pressing natural resource issue at the site. Natural revegetation is helping to obscure the site however, some revegetation is needed in areas where no natural recruitment is occurring.

Fig. 81 – Road cut push pile looking back towards Munson Valley Rd.

Fig. 83 – Pumice from off-site is spread out over road cut.

Fig. 82 – Road cut with debris and logs moved to cover road.

Fig. 84 – Rocks placed in erosional gully.

14. Highway 138 Crushed Rock

Location: Site located about 200 feet south of highway 138 across from Forest Service access road marked “Crater Trail”. Old Diamond Lake Road leads into the park to the site.

GPS: 4770943 N, 572257 E, +/- 14’, NAD 83

Date of visit: August 25, 2008

Description: Old Diamond Lake Road leads into the site. Rock piles are on the west side of the road. One pile of crushed rock is located about 200 feet south of hwy. 138 and is about 20’x30’x5’ high. This pile is naturally revegetating with lodgepole (*Pinus contorta*) of various ages. A smaller pile 5’x5’x4’high is located closer to the road about 10 feet south of the first pile. This smaller pile has only one *P. contorta* from natural recruitment. No weeds were seen at the site.

Recommendation: The old Diamond Lake Road and rock piles are naturally revegetating with *P. contorta*. Recommend leaving natural recruitment continue.

Fig. 85 – Old Diamond Lake Road with *P. contorta* volunteers leads to the site.

Fig. 86 – Larger rock pile as viewed from Old Diamond Lake Rd.

Fig. 87 – Larger rock pile with *P. contorta* volunteers.

Fig. 88 – Smaller rock pile with one *P. contorta* volunteer.

15. Lodge Dump Road

Location: Directly east of east end of lodge across paved walkway. View of beginning of road is obscured by large boulders.
GPS: 4751048 E, 570265 E, +/- 14 ft. NAD 83
Date of visit: August 5, 2008.

Description: Partly eroding road bed leads down to the east of the east side of lodge.

Current Conditions: Obvious road bed about 1 foot below grade. Road is naturally re-vegetating except in eroding areas which appear to be worsening. Some trash debris along the road (broken glass/ceramics, roofing shingles, paper, etc.).

Recommendation: Eroding section should be stabilized. Natural revegetation could be augmented with native seed however this is not a priority site so natural recruitment will do the job.

Fig. 89 – Road heading southeast from east side of Crater Lake Lodge.

Fig. 90 – Old roadbed looking back toward Lodge.

Fig. 91 – Some erosion occurring on steeper grade.

Fig. 92 – Old road disappears as it nears tree line.

16. North Entrance Crushed Rock

Location: 1.4 miles north of Pumice Desert turnout on North Entrance Road. Old road bed on right leads east to site which is located ¼ mile from hwy. on the left.
GPS: 4766531 N 571805 E, +/- 11', NAD 83
Date of visit: July 10, 2008

Description: Two mounds (~4' high) of crushed rock of different sizes including pumice, gravel and 5-10" rocks. Habitat consists of *Pinus contorta* (Lodgepole pine) with a sparse understory of grasses.

Current Conditions: *Pinus contorta* is colonizing the site. No weeds seen.

Recommendations: Area is naturally revegetating and is small in scale. Recommend letting this site continue on with natural revegetation.

Fig. 93 – Access road from North Entrance Road blocked by boulders.

Fig. 94 – Roadbed leads to rock piles and Pumice Desert Borrow Pit (pg. 45).

Fig. 95 – Roadbed with rock pile on left.

Fig. 96 – Rock piles naturally revegetating.

17. Pacific Crest Trail (PCT) North Parking Area Rock Pile

Location: From PCT parking area walk west on trail .2 miles. Rock pile is on the left about 20 feet from trail.

GPS: 47600630 N, 570330 E, NAD 83

Date of visit: July 10, 2008

Description: Pile (10'x10' area) of soil and rocks. Old post on the east side of pile.
Current Conditions: Pile is colonized by *Pinus contorta* of various ages. No weeds seen.

Recommendations: Area is naturally revegetating and is small in scale. Recommend letting this site continue on with natural revegetation.

Fig. 97 – Rock pile about 30 feet from of Pacific Crest Trail.

Fig. 98 – Rock pile with *P. contorta* volunteers naturally revegetating.

Category Q: Large Scale Quarry Sites

18. Andersen Bluffs Quarry, Post Site and Rock Pile

Location: Old spur road (gated) on the east side of Pinnacles Road. Quarry area includes several rock/gravel piles that begin in the clearing just to the west of the quarry.
GPS: 4750819 N, 576640 E, +/- 20 ft. NAD 83.
Date of visit: July 15, 2008

Description: Large rock quarry at the base of Anderson Bluff. Several large rock and gravel piles in the immediate vicinity to the west of the quarry. Quarry has not been used for about 15 years (Steve Thomas pers. comm.) Rock piles and post site are adjacent to the quarry.

Current Conditions: Rock and gravel piles are naturally revegetating with *Pinus contorta* (Lodgepole pine). Yellow Rocket weed (*Barbarea vulgaris*) was found on the first rock pile to the right as you enter the clearing. The roads crew does continue to use crushed rock from the site.

Recommendations: This area would be a major restoration project including the removal of some potentially hazardous material (old creosote logs) and the eradication of weeds.

Fig. 99 – Entrance to quarry.

Fig. 100 – Piles of rock below quarry with access road.

Fig. 101 – Rock quarry with view to the north.

Fig. 102 – Rock pile area on the way to quarry.

Fig. 103 – Piles of various sizes of rock and gravel on the way to quarry.

Fig. 104 – Kathryn Williams investigating rock pile with Yellow Rocket weed (*Barbarea vulgaris*).

Fig. 105 – Rock site gravel pile with Shasta red fir (*Tsuga mertensiana*) and Lodgepole (*P. contorta*) volunteers.

Fig. 106 – Debris in vicinity of rock piles.

Fig. 107 – Anderson Bluffs Post Site.

Fig. 108 – Metal barrels and debris at post site.

19. Grayback Quarry

Location: Take East Rim Drive past Sun Notch. Park at first paved pullout at southernmost tip of Dutton Ridge. Walk south along Grayback Ridge about ¾ mile to upper quarry.
GPS: 575414 E, 4747274 N, +/- 7', NAD 83
Date of Visit: September 10, 2998

Description: Very lage rock quarry on face of Grayback Ridge, not used since the 1940's. Old road bed from Grayback road circles lower quarry and leads to upper, smaller quarry.

Current Conditions: This quarry is unique because it is one of the few that can be seen from East Rim Road. The area is naturally revegetating with Mt. Hemlock, Shasta red fir, lodgepole pine, pinemat manzanita, Erigonum sp., grasses and sedges.

Recommendations: This is a very large quarry area and would take significant earth moving to restore the site. Although it can be seen from Rim Drive, the area is naturally revegetating. Recommend allowing mother nature to continue the process.

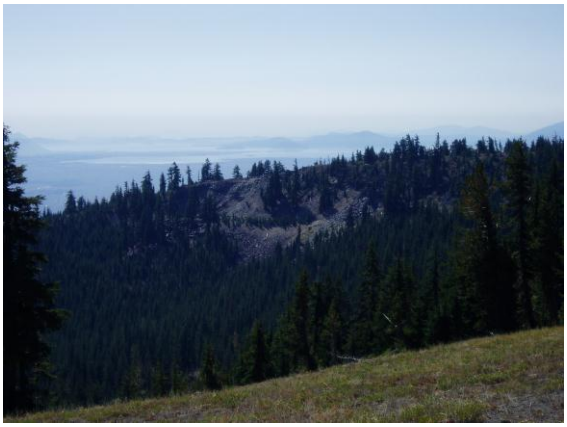

Fig. 109 – Grayback Quarry as seen from East Rim Drive.

Fig. 110 – Grayback Quarry looking into lower site and cliff face.

Fig. 111 – Grayback Quarry looking down cliff face into lower site and access road.

Fig. 112 – Grayback Quarry upper site with natural revegetation.

20. Pole Creek Quarry and Dumpsite

Location: Hwy. 62 S. between Lodgepole Picnic Area and Munson Valley Road.
GPS: 569199 E, 4743942 N, +/- 20', NAD 83.
Date of visit: September 10, 2008.

Description: Dumpsite is a "boneyard" used by the Roads Crew to store logs, rocks and other materials. Quarry is up an access road to the north and is approximately 300' across by 200' high. Near the quarry is another flat area that appears to be used for filling water tankers from the creek.

Current Conditions: Dumpsite has a large amount of logs, stumps, rock piles, gravel, asphalt, wood chips and other piles of debris with some trash mixed in. Quarry looked clean except for an old burned out car. No weeds were seen. This is an active site used by the Roads Crew to dispose of all of the above mentioned materials and to use rocks and trees/logs for other projects.

Recommendations: This is a huge site with large impacts from debris and heavy machinery. Since it's an active site it does not make sense to embark on revegetation.

Fig. 113 – Pole Creek Dumpsite tree and log storage with road to quarry in background.

Fig. 114 – Pole Creek Dumpsite gravel and asphalt piles.

Fig. 115 – Pole Creek Dumpsite rock piles and wood chip pile.

Fig. 116 – Pole Creek Dumpsite asphalt and debris piles.

21. Pumice Desert Borrow Pit

Location: 1.4 miles north of Pumice Desert turnout on North Entrance Road. Old road bed on right leads east to the site which is located about ¼ mile from hwy. on the right, past the North Entrance Crushed Rock pile.

GPS: 4766583 N, 571848 E, NAD 83

Date of visit: July 10, 2008

Description: Old pumice pit about 50'x 100'. Habitat consists of *Pinus contorta* (Lodgepole pine) with a sparse understory of grasses.

Current Conditions: Side entrance road into pit is eroding but becoming colonized by *Pinus contorta* (lodgpole pine). Lodgpole are colonizing the entire site with some trees as large as 10 feet. No weeds seen.

Recommendations: Area is naturally revegetating and is small in scale. Recommend letting this site continue on with natural revegetation.

Fig. 117 - Access road from North Entrance Road blocked by boulders.

Fig. 118 - Roadbed leads to Pumice Desert Borrow Pit and North Entrance Rock Pile (pg. 45).

Fig. 119 – Spur road leads to the right to borrow pit.

Fig. 120 – Entrance to borrow pit *with P. contorta* volunteers.

Fig. 121 – Borrow pit with naturally revegetating *P. contorta*.

Fig. 122 – Borrow pit with several age classes of *P. contorta* volunteers.

22. Roundtop Quarry

Location: Off of West Rim drive. Road begins just east of gravel pullout on north side of road NE of Roundtop.
GPS: 4757794 N, 577321 E, +/- 25'. NAD 83.
Date of visit: August 27, 2008.

Description: Road leads downgrade then up to large cliff face quarry. Quarry is about 100' wide and about 60' upslope to the road grade above. Piles of rock line the road as you access the site. This site has not been used by the Roads Crew since the early 1990's (Steve Thomas, roads foreman personal communication).

Current Conditions: Road that leads to the site is developing large erosion gully. Piles of different size rocks and rubble surround the perimeter of the quarry. Some lodgepole (*Pinus monticola*), manzanita (*Arctostaphylos navadensis*), and grass sp. are colonizing the rock piles and gravel/pumice substrate. No weeds were seen at the site.

Recommendations: This is a very large site, which would take significant earth moving equipment to restore. The most urgent condition is the erosion gully developing along the road bed.

Fig. 123 – Roundtop Quarry access road from West Rim Dr.

Fig. 124 – Roundtop Quarry access road with erosion gullies.

Fig. 125 – Roundtop Quarry with some lodgepole and manzanita volunteers.

Fig. 126 – Roundtop Quarry looking up to the West Rim Road grade.

Fig. 127 – Roundtop Quarry pumice and rock piles with lodgepole volunteers.

Fig. 128 – Roundtop Quarry entrance with pumice piles.

Fig. 129 – Roundtop Quarry access road with pumice piles blocking road on left.

Fig. 130 – Roundtop Quarry access road with pumice piles blocking road.

Fig. 131 – Roundtop Quarry as viewed from entrance road.

Fig. 132 – View towards Mt. Scott from Roundtop Quarry.

Suggestions for Future Revegetation

I recommend the following priority sites for future revegetation:

Site 12, pg. 37- Whitebark pine picnic area – needs complete overhaul (change of traffic flow, paved parking spots, interpretive signs) and revegetation.

Site 10, pg. 34 - North Junction Overlook – needs complete overhaul and revegetation.

Site 2, pg. 11 - Lost Creek Campground – needs revegetation of the leach field area, campsites #1 and #2 to stop runoff into Lost Creek from Grayback road and run off from Revegetetation Site #6.

Site 3, pg. 15 - Sun Notch Overlook needs revegetation along the rim and the small meadow social trail.

Site 1, pg. 8 - Vidae Falls Picnic Area needs revegetation around the restroom and removal of old erosion matting.

Site 13, pg. 38 - Fish Construction site needs revegetation, erosion control, and possible restoration of historic road.

Other "Orphan" Sites

South Yard – Located on hwy. 62 in the panhandle. This is another major storage site that is currently used as a boneyard for the roads and maintenance crews. No weeds were seen during site visit.

The following were searched for using the UTM's and physical directions in the database but could not be located. UTM's are of unknown NAD which made location of some sites difficult. Conversations with park staff (Steve Mark, Cheri Killam-Bomhard) indicate that these sites are naturally revegetating and do not need active management, however another attempt to document these sites could be done next year.

Hwy. 62 Camp
Whitehorse Quarry
Llao's Outhouse
Whitehorse Reservoir
Cold Spring Campground
Old North Entrance Gate
North Entrance Well Site
North Entrance Ranger Station

The following were not visited during the summer 2008:

Red Cone Backcountry Camp
Bybee Creek Backcountry Camp
Crater Peak Ranger Station

Literature Cited

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